
Dayneutral Strawberry: Potential for Farm Production Diversification in Southwestern Ontario

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Abstract: Growing consumer demand for year-round supply of fresh strawberries in Ontario justifies cropping of dayneutral strawberry to extend the growing season. Currently they are grown on about 20% of the strawberry acreage in Ontario, and the harvest season has been expanded from six weeks to six months. This study assessed current dayneutral strawberry production technology, calculated cost of production, and evaluated effects of varying sale prices, channels of sale and yields on returns. The data were grower-generated and collected through paper-based surveys of existing dayneutral strawberry growers. The surveys were conducted in 2011 and 2012 in southwestern Ontario. Study results demonstrated that dayneutral strawberry production was labor and resource-intensive, but an economically viable enterprise. The net revenue was channel-of-sale and yield dependent.

Keywords: Production Cost, Dayneutral, Strawberry, Return

1. Introduction

Development of dayneutral strawberry cultivars provided an opportunity for Ontario growers to diversify farm production through expansion of the strawberry production season from four to six weeks to four to six months [16]. However, the adoption of this alternative type of strawberry production used for either season extension and/or off-season production, is faced with several challenges. The challenges are: lack of adaptability of current cultivars to the short season in Ontario, labor and resource-intensive production, complicated cultivation technology, vegetative propagation difficulties and lack of production, marketing and financial information. Overcoming these challenges are significant contributions in maintaining or increasing farm productivity and supplying fresh strawberries during the off-season of traditional strawberry harvest.

From a breeding point of view, the lack of adaptability of

current dayneutral cultivars to short season production and propagation difficulties are two top challenges [4, 9]. To overcome these challenges, [4] recommended to use short day germplasm as parents or, test dayneutral native germplasm in a short-day season environment earlier in the breeding cycles. The development of seed propagated F1 strawberry hybrids could eliminate limitation of vegetative propagation of dayneutral cultivars [4, 6].

The field work is unevenly distributed throughout the growing season [16]. Many growers find it challenging to fit dayneutral strawberry production into a diversified farm operation. This requires further farm operations “fine tuning” [16]. Any attempt to grow dayneutral strawberry as a traditional strawberry crop would result in failure and disappointment [16, 8]. For instance, dayneutral strawberries are well adapted for growth on raised beds with trickle irrigation and plastic mulch. Attempts to grow them in matted rows would result in yield reduction up to 50% [17]. Also,

planting date and type of planting material affect harvest time. Staggered harvest of dayneutral strawberry during off-season for short day strawberry production demands higher sale price, which creates difficulties in berry sale particularly at the beginning of adoption of dayneutral strawberry cultivation. Inadequate weed and pest management will result in substantial yield reduction. Current dayneutral strawberry growers have many modified cultivation systems (plant type, plant size and planting date) and a number of potential cultivars to be investigated and/or further modified to fit within their farm production environment [17, 8, 3, 20, 7].

To make an informed decision to extend the strawberry growing season with dayneutral cultivars, adopt this strawberry production system and/or leave this operation, current and potential strawberry growers need reliable production, marketing and financial information. The best information should come from detailed records kept by the growers themselves that would serve as a reference point in making these decisions. However, this typically does not happen for all growers. Some growers are “in a learning stage” of dayneutral strawberry production, so they are unable to generate reliable production records or simply do not have the time to keep detailed records, particularly smaller growers. Also, economic analysis can identify those factors that have the biggest impact on the strawberry industry and help researchers to allocate resources to projects with the largest positive impact on growers’ return [15]. In Ontario, no study has been conducted to investigate cost associated with dayneutral strawberry production.

In Canada, in 2009, 103,070 tonnes of strawberries were imported, while 19,190 tonnes were produced domestically. Therefore, domestic strawberry production meets about 18.6% of the Canadian fresh market demand [19]. However, the movement to “buy local” products has created significant interest for locally grown produce. The estimate is that in Ontario, this market will continue to grow [13]. Consumers are willing to pay a premium price for locally grown produce since it is identified with better nutrition, fresher, better quality, better taste and helps the local community [1, 12].

The objectives of the research was to assess: 1. current dayneutral strawberry production technology, 2. calculate cost associated with that production, and 3. evaluate the effects of varying sale prices, channels-of-sale and yields on returns in Ontario.

2. Materials and Methods

To accomplish the research objectives, a survey questionnaire was developed. The survey method was used since neither Ontario nor Canada have a system framework for farm accountancy data collection, such as Farm Accountancy Data Network in the European Union. The survey was conducted in 2011 and 2012 in southwestern Ontario. The paper-survey was sent out to 31 growers with dayneutral strawberry production, 16 responded and nine were used for this analysis. The survey questionnaire was divided into five expense categories: cultivation practices,

harvest, materials, external services and overhead, labor and machinery and equipment.

Cultivation practices information was based on management practices for dayneutral strawberry production outlined in [5] and recommendations by the Ontario Ministry of Agriculture Food and Rural Affairs [3]. The cultivation practice section was, further, divided into: 1) preplant 2) planting year and first harvest and 3) second production and harvest year. For each cultivation practice, data were collected on materials, labor, machinery and equipment used, number of operations performed and completion time required. The survey examined cost for irrigation set up and cost to irrigate dayneutral strawberries. The questionnaire provided options for growers to include any cultivation practice regularly performed on farm but not anticipated in the questionnaire.

Harvest data included labor (number of people involved in harvest), harvest time, packaging material type and price, quantity and assembly time needed to organize packaging materials, strawberry transport to a cooler and sale outlet and cost of strawberry cooling. Also, this section collected data on yields, channel-of-sales (percent of total sale) and average sale price. The researchers also collected information on marketing venues and cost incurred. The yields were reported as multi-year average of marketable fruit per farm, regardless of number of cultivars harvested.

Materials, external service and overhead data included input used in preplant, planting and care in first harvest year and care and harvest in second production year. The input information was on type and quantities. The input prices were obtained from local dealers and Ontario Farm Input Monitoring Program, published by University of Guelph for 2011 and 2012 growing seasons. The price did not include any discount, out-of-country purchase or benefits of membership to various associations and groups. External services included soil and plant analysis, field scouting and irrigation pond excavation or renewal. Overhead information included food safety, hiring staff, land charges, product marketing, various journal subscription and association memberships and office administration expenses to run the farm.

Labor information included labor source and wages. Ontario farmers staff farms from three distinct employee groups: 1) local seasonal, 2) Temporary Foreign Worker Program managed by Federal Government and 4) permanent farm staff. Minimum wage in Ontario in 2012 was €7.28 per hour. This labor cost was adjusted 21% to reflect estimated payroll taxes and vacation pay as required under provincial and federal government regulations.

Machinery and equipment costs included amortization/depreciation, insurance, housing, repair, maintenance fuel and lubrication. If machines were used for other farm operations, the costs were adjusted based on the proportion of use on strawberry production. The calculation methods were outlined in [10] and [14]. The machinery and equipment purchasing cost were not included in this analysis. The calculations were expressed per hectare. The descriptive

statistical analysis was performed by using general linear model (GLM) [21].

3. Result and Discussion

Total production, harvest and marketing cost of dayneutral strawberries in Ontario were calculated at € 60,948 / ha. Expenses were also separated into three production phases: 1) preplant operations (Table 1), 2) planting of dormant plants, plant care and harvest operations in first production year (Table 2), and 3) plant care and harvest operations in second production year (Table 3). Planting, plant care and harvest operations in first production year were the most expensive phases, costing an estimated € 30,743 / ha, or 50.5% of the total cost (Table 2), while plant care and harvest operations in second production year were the second most expensive phase costing € 25,050 / ha, or 41% of the total (Table 3).

The cost of preplant operations were estimated to be € 5,155 / ha or 8.5% of the total cost (Table 1). Overall labor accounted for 49.2%, or € 29,979 /ha, of the total estimated expenses, materials cost were slightly under 39%, or € 20,654 /ha, and costs linked to operating the equipment,

external service, overhead and miscellaneous expenses comprised almost 12% or €10,315 / ha (Table 5). In Quebec, a study in 2007 estimated that total cost of the dayneutral strawberry production was € 51,631 /ha. The return was €28,705 /ha, with an average yield of 21,600 kg/ha and an average sale price of € 3.48 /kg (regardless of sale channel) [2].

The surveyed growers adopted a production system with dormant plants planted on raised beds with trickle irrigation and plastic mulch. The actual expenses for the cost of major production operations in the preplant phase is given in Table 1. Field fumigation and bed formation accounted for 2/3 of all preplant expenses. On average surveyed farms used little over 9 t/ha of manure and about 5 t/ha of lime. This production phase was the least expensive in dayneutral strawberry production. In this production system, the preplant operations were usually done in the fall prior to the planting year, some growers opted for preplant operation to be done early in the planting year. Apparently, the timing depended on work force availability and planting dates. Reference [18] reported that preplant operations were the most expensive operations in a system with plug-plants planted on raised beds.

Table 1. Total preplant operations cost of dayneutral strawberry production (€/ha).

Operation	Fuel, lube & rprs	Labor	External service	Materials	Total	(%)
1. Tillage: soil saver	76	18		0	94	1.8
2. Herbicides (PP)	24	14		50	87	1.7
3. Manure	93	36		205	334	6.5
4. Lime	23	18		153	195	3.8
5. Cultivate	57	23		0	80	1.5
6. Fumigate	170	65		1,404	1,639	31.8
7. Layout field	27	29		0	56	1.1
8. Make beds	205	72		1,688	1,965	38.1
9. Straw	124	58		282	464	9
10. Irrigation pond			241	0	241	4.7
Total cost	800	332	241	3,782	5,155	100
Total cost (%)	15.5	6.4	4.7	73.4	100	

The cost associated with planting, care and harvest in the first production year are shown in Table 2. The largest expense was related to berry harvest, transport and cooling operations and accounted for just over 48.4%. The cost of labor and materials comprised 84.4% (46.3% and 38.1%, respectively). The largest material expense was the cost of strawberry plants. The surveyed growers planted on average about 49,500 plants/ha. It took 96 hours to plant one hectare dormant strawberry plants on raised beds by combining machine and hand planting. The most of growers did hand planting. In the second production year the cost associated

with harvest increased just over 19%, while the labor and materials cost dropped about 2.3% over the cost associated with dayneutral strawberry production in the first harvest year (Table 3). The second most expensive operation was activities related to winter and early spring frost protection. This operation accounted for over 10%. Based on the results of this study, the view that dayneutral strawberry production was labor and resource intensive enterprise appears to be correct. The summary of overhead expenses are given in Table 4.

Table 2. Dayneutral strawberry production expenses in establishment and first bearing year (€/ha).

Operation	Overhead	Equipment fuel, lube & repair	Labor	External service	Material	Misc.	TOTAL	(%)
1. Test irrigation system		36	40				76	0.2
2. Hand planting		88	966		5,020		6,075	19.7
3. Ferti-irrigation		418	354		1,429		2,201	7.2
4. Herbicides		82	50		190		322	1
5. Insecticides		70	43		614		728	2.4
6. Fungicides		164	101		936		1,201	3.9
7. Runner and flower removal			1,053				1,053	3.4

Operation	Overhead	Equipment fuel, lube & repair	Labor	External service	Material	Misc.	TOTAL	(%)
8. Weeding			529				529	1.7
9. Harvest set up		27	29		38		94	0.3
10. Harvest			10,811		2,011		12,823	41.7
-transport berries						1,586	1,586	5.2
-cooling berries						378	378	1.2
11. Cultivation		41	18				58	0.2
12. Removal irrigation equipment		38	27				65	0.2
13. Winter protection		79	213		1,475		1,768	5.7
14. Field Scouting				366			366	1.2
15. Leaf analysis				221			221	0.7
16. Overhead	1,199						1,199	3.9
TOTAL COST	1,199	1,043	14,235	586	11,715	1,965	30,743	100
TOTAL COST (%)	3.9	3.4	46.3	1.9	38.1	6.4	100	

Table 3. Dayneutral strawberry production expenses in second bearing year (€/ha).

Operation	Overhead	Equipment fuel, lube & repair	Labor	External service	Material	Misc.	TOTAL	(%)
1. Winter protection			103				103	0.4
2. Test irrigation		38	41				79	0.3
3. Ferti-irrigation		389	314		1,021		1,725	6.9
4. Herbicides		57	35		175		267	1.1
5. Insecticides		86	53		564		703	2.8
6. Fungicides		108	66		667		841	3.4
7. Weeding			352				352	1.4
8. Harvest set up		27	29				56	0.2
9. Harvest			11,985		2,731		14,716	58.8
-transport berries						1,776	1,776	7.1
-cooling berries						424	424	1.7
10. Field scouting				94			94	0.4
11. Removal irrigation equipment		36	45				81	0.3
12. Winter cover removal		73	2,370	124			2,567	10.2
13. Disking		69	18				87	0.3
14. Overhead	1,179						1,179	4.7
TOTAL COST	1,179	883	15,411	218	5,157	2,200	25,050	
TOTAL COST (%)	4.7	3.5	61.5	0.9	20.6	8.8		

Table 4. Summary of overhead expenses in dayneutral strawberry production (€/ha).

Expenses	€/ha	(%)
1. Food safety	67	5.7
2. Labor (hiring cost, transport shopping, visit to doctor etc.)	255	21.6
3. Land cost	195	16.5
4. Advertisement	244	20.7
5. Farm administration (office cost, bookkeeping, memberships)	418	35.5
TOTAL	1179	100

Table 5. Summary cost of dayneutral strawberry production (€/ha).

Expenses	Preplant	1 st year operations	2 nd year operations	Total	TOTAL%
Machine	800	1,043	883	2,726	4.5
Labour	332	14,235	15,412	29,979	49.2
External service	241	586	219	1,046	1.7
Material	3,782	11,715	5,157	20,654	33.9
Overhead	-	1,199	1,179	2,378	3.9
Misc.	-	1,965	2,200	4,165	6.8
TOTAL	5,155	30,743	25,050	60,948	100
TOTAL%	8.5	50.4	41.1	100	

Net revenue depended on yield, channel-of-sale and the price growers receive for their strawberries. As in most farming operations, growers' experience and aptitude toward advances in strawberry research can have a tremendous influence on their crop yields. The better the job they do in caring for the crop, the more likely they will have higher

yields and better berry quality. The total marketable yields were relatively high providing that some growers are new to dayneutral strawberry production. The total yield ranged from 11,200 kg/ha to 28,000 kg/ha with an average of 21,233 kg/ha (Table 6).

Table 6. Yields of dayneutral strawberry production (kg/ha).

Location	1 st harvest year	2 nd harvest year	TOTAL
1	10,342	13,440	23,782
2	11,000	16,800	28,000
3	8,951	13,436	22,387
4	9,184	9,184	18,368
5	12,880	12,880	25,760
6	10,080	5,600	15,680
7	6,720	4,480	11,200
8	8,960	12,880	21,840
9	12,880	11,200	24,080
Average	10,133	11,100	21,233

Growers with experience in growing strawberries and growers who readily cooperate with researchers attained the highest yields. The average marketable yield achieved was approximately 50% of the yield potential of dayneutral strawberries [5]. The yield potential represented the average yield achieved by the breeder in a cultivars trial under optimal production conditions for the purpose of a cultivar release [7]. Surveyed growers have identified cultivar, plant type, planting date selection and weed and pest control as areas for future research to be focused for yield and sale improvement. Indeed, cultivars adapted to local environments, insect and disease resistant cultivars with larger, higher quality and more appealing berries increase yield and promote sales of fresh strawberries [11]. Plant type (bare root and plug plants) and planting date optimize harvest in off-season, which, in turn, demand higher sale prices [16]. Weeds and pests can be major problems in dayneutral plantings. Late and inadequate control measures would substantially reduce the yield and fruit marketability [5].

The local market and channel-of-sale determined the maximum price for which growers can sell their berries. The survey of nine growers revealed that there was significant variation in the channel-of-sale and the prices they charged for U-pick, wholesale and berries sold at the farm gate and local farmers' market. The survey revealed that U-pick, wholesale and berries sold at the farm gate and local farmers' market on average contributed sales at the proportion of 15%, 55% and 30%, respectively. The average volume of strawberries sold U-pick outlet was 1,592 kg/ha with revenue of €6,018 /ha per harvest year (Table 8). The lack of growers'

Table 8. Financial results in dayneutral strawberry production cycle (€/ha).

Elements	U-Pick (15%)	Wholesale (55%)	Farm gate (30%)	TOTAL
Revenue in 1 st year	5,747	18,182	18,128	42,057
Revenue in 2 nd year	6,289	18,896	19,658	45,843
Total revenue	/	/	/	87,900
Total cost	/	/	/	60,948
Return (Revenue-Cost)	/	/	/	26,952

It is also important for strawberry growers to determine their break-even yields, i.e. minimum volume of fruits needed to be sold to cover production and marketing cost so-called the point of zero profit. Selling volume of fruits below break-even yields will result in a negative financial position while selling over the break-even yield will generate positive financial position and growers will make a profit. The break-

interest in U-pick channel-of-sale, particularly novice growers, was because of the smaller berry size and irregular shape (cultivar dependent), particularly in the second harvest year. The harvest management difficulties were also quoted as a cause for lack of growers' interest in U-pick. One grower sold all berries at the farm gate and local farmers' market. The majority of growers sold dayneutral strawberries wholesale (Table 7).

U-pick prices ranged from €2.78 /kg to € 6.04 /kg, with an average of € 3.78 /kg. Eight growers reported wholesale and the sale price ranging from € 2.4 /kg to € 4.49 /kg, with an average of € 3.26 /kg. The highest sale price was achieved at the farm gate and local market outlets. The price ranged from €4.52 /kg to € 8.36 /kg, with an average of € 5.96 /kg. On average, the largest price differential was between wholesale and local farmers' market outlets (€ 2.7 /kg), while the smallest price gap was between U-pick and wholesale outlets (€ 0.52 /kg). The price differential between U-pick and farm gate and local farmers' market sale was € 2.18 /kg (Table 7).

Table 7. Prices and average price per market (€/kg).

Location	U-Pick	Wholesale	Farm gate
1	/	2.81	/
2	/	2.81	/
3	2.78	2.44	/
4	/	3.45	4.81
5	/	2.44	5.89
6	6.04	4.22	8.36
7	/	/	4.52
8	2.51	4.49	6.28
9	/	3.45	5.89
Average	3.78	3.26	5.96

Table 8 provides a break-down of financial results in dayneutral strawberry production in Ontario. Total revenue was €87,900 /ha, while operating expenses were € 60,948 /ha. The net revenue of € 26,952 /ha was achieved. This net revenue was based on only 50% of cultivar performance. Addressing this performance issues with adequate plant care without additional input, the financial benefits to growers from growing dayneutral strawberries could be even greater (Figure 1).

even yields were calculated for various combination of U-pick, wholesale and farm-gate-prices (Figure 1).

It was estimated that growers would not receive a positive net return at any of the price combinations under the results of this survey if they achieved a yield of 10,500 kg/ha or less. Given a marketable yield of 12,500 kg /ha, growers would only receive a positive return with highest prices. Positive net

revenues were also projected for prices combination higher than €2.84 /kg, €2.49 /kg, €4.94 /kg, for each market respectively if yield of 17,500 kg /ha were attained (Figure 1).

Obviously, the lower the prices charged for each market outlet the more berries needed to be sold to cover incurred costs. For example, a U-pick price of €2.50 /kg combined

with € 2.10 /kg for wholesale and €4.60 /kg for on farm sale means that growers would have to sell 22,442 kg / ha of berries to cover incurred costs. However, if a grower can sell the berries for the highest price for each market segment, the berries quantity needed to be sold drops to 11,561 kg/ha to break-even (Figure 1).

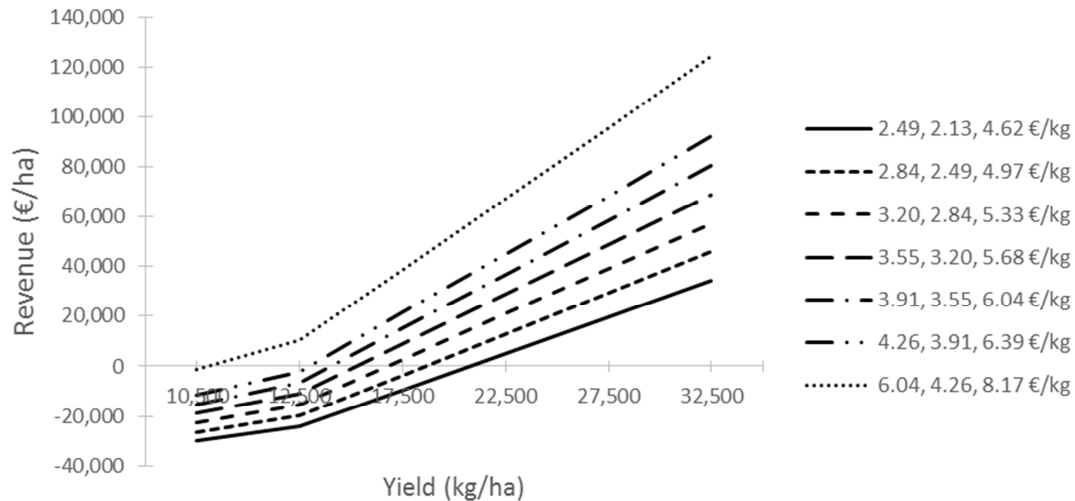


Figure 1. Estimated net revenues per hectare for dayneutral strawberries grown in southwestern Ontario for varying marketable yield levels and price levels if 15% of strawberries sold as U-pick, 55% as wholesale and 30% at the farm gate and local markets with sale prices, respectively.

4. Conclusion

This study analysed current dayneutral strawberry production technology, cost associated with the production and evaluated the effects of varying sale prices, channels-of-sale and yields on returns in southwestern Ontario. Although, we still have numerous unanswered “research questions” related to identifying suitable dayneutral cultivars for Ontario growing conditions and optimum production methods, the results showed that the dayneutral strawberry crop is an economically viable farm production enterprise. Therefore, we recommend that growing dayneutral strawberries for summer and fall fruiting in Ontario be considered a viable potential crop for former tobacco growers and/or existing strawberry growers seeking an alternative crop to diversify farm operations.

The results also affirmed that dayneutral strawberry production was labor and resource-intensive enterprise. Knowledge and attention to details are required at all stages of berry production, from planting and crop management, berry harvest to marketing and sales. Surveyed growers on average achieved about 50% of marketable yield potential. Therefore, better crop management would allow the yield increase without additional capital investment, consequently achieving higher net returns.

Net returns were highly affected with channel-of-sale. Pre-picked channels-of-sale (wholesale and farm gate sale) commanded higher sale price. U-pick sale channel was not widely accepted as a dayneutral strawberry sale outlet.

The main limitation to this study was that there were a relatively small number of respondents from grower surveys. This was because a relatively small number of growers

collected sufficient, reliable production information. Some growers were still in “an experimental” production phase and a number of growers did not want to share “trade secrets”, since their perception was that local strawberry growers were the competition, not large multinational companies.

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